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Docket No.: GR 97 P 1593 P

  
XIOMARA D. JUNCO

Date: November 9, 1997

Hon. Commissioner of Patents and Trademarks  
Washington, D.C. 20231

Sir:

Enclosed herewith are the necessary papers for filing the following application for Letters Patent:

Applicant : Andreas Lenniger et al.

Title : Power Semiconductor Module With Ceramic Substrate

1 sheet of formal drawings in triplicate.

A check in the amount of \$760.00 covering the filing fee.

Information Disclosure Statement and 11 References.

PCT Publication (cover sheet only).

This application is being filed without a signed oath or declaration under the provisions of 37 CFR 1.53(d). Applicants await notification of the date by which the oath or declaration and the surcharge are due, pursuant to this rule.

The Patent and Trademark Office is hereby given authority to charge Deposit Account No. 12-1099 of Lerner and Greenberg, P.A. for any fees due or deficiencies of payments made for any purpose during the pendency of the above-identified application.

Respectfully submitted,



For Applicants

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LAG:djp

**REG. NO. 34,956**

POWER SEMICONDUCTOR MODULE WITH CERAMIC SUBSTRATE

5 Cross-Reference to Related Application:

This is a continuation of copending International Application PCT/DE98/01266, filed May 7, 1998, which designated the United States.

10 Background of the Invention:

Field of the Invention:

The invention relates to a power semiconductor module with a plastic housing into which a substrate is inserted as a housing base. The substrate contains a ceramic plate provided with a metallization layer on top and bottom sides. The metallization layer on the top side of the ceramic plate faces an interior of the housing and is patterned in order to form interconnects. The power semiconductor module is equipped with semiconductor components and connecting elements, and in which terminal elements for external terminals are introduced.

Such power semiconductor modules have been known for a long time. In the case of these power semiconductor modules, the terminal elements for the external terminals are disposed in the plastic housing. In this case, the terminal elements, which are composed of copper as a rule, are injection-molded

into the plastic housing. However, plastic has the property of shrinking when it cools, in other words after the injection molding. The result of this is that the terminal elements are not, as a rule, anchored fixedly in the plastic. Wires are bonded onto the terminal elements in the interior of the housing, the other end of which wires is bonded onto the semiconductor components. These wires are composed of aluminum as a rule. By virtue of the fact that the plastic shrinks after the injection molding, however, it can happen that, owing to the poor mechanical fixing of the terminal elements in the plastic housing, the bond present in the interior of the housing may become detached. This leads to the failure of the power semiconductor module.

#### Summary of the Invention:

It is accordingly an object of the invention to provide a power semiconductor module with a ceramic substrate that overcomes the above-mentioned disadvantages of the prior art devices of this general type, which exhibits very good mechanical fixing of the terminal elements, with the result that the above-mentioned problems do not arise. Furthermore, the object of the present invention is to further simplify the method for producing the plastic housing.

With the foregoing and other objects in view there is

provided, in accordance with the invention, a power semiconductor module, including:

semiconductor components;

5

a plastic housing having an interior and connecting element openings formed therein;

10

a substrate disposed in the plastic housing defining a housing base of the plastic housing, the substrate containing a ceramic plate having a top side and a bottom side with a top metallization layer disposed on the top side and a bottom metallization layer disposed on the bottom side, the top metallization layer facing the interior of the plastic housing being patterned in order to form interconnects and equipped for and receiving the semiconductor components;

15

connecting elements interconnecting the semiconductor components; and

20

terminal elements for providing external terminals press-fitted into the connecting element openings in the plastic housing.

This object is achieved according to the invention by virtue of the fact that the terminal elements are press-fitted into openings in the plastic housing.

5 As a result of this measure, the metal parts are fixed into the plastic housing by a relatively simple method. In particular, this method does not need a separate injection mold into which the terminal elements are placed before each injection-molding process and subsequently encapsulated by the  
10 injection molding.

Furthermore, as a result of the terminal elements being press-fitted into the openings in the plastic housing, the elements are anchored considerably better therein, thereby enabling  
15 reliable bonds in the interior of the housing.

In a development of the present invention, the terminal elements have lugs that bear on an inner side of the plastic housing and fix the terminal elements in their position. The  
20 lugs are preferably configured as barbs, with the result that the terminal elements are guided tightly in the openings and secured from withdrawal. It is also conceivable for the terminal elements to be provided with offsets that fix the terminal elements in the openings.

25

The terminal elements expediently have regions in the interior of the housing which run approximately parallel to the housing base. This considerably facilitates the bonding process.

- 5 The plastic housing typically contains a frame and a cover, the terminal elements being disposed in the frame.

The substrate is covered, within the housing, with a potting compound that serves to encapsulate the substrate in a  
10 moisture-tight manner.

Other features which are considered as characteristic for the invention are set forth in the appended claims.

- 15 Although the invention is illustrated and described herein as embodied in a power semiconductor module with a ceramic substrate, it is nevertheless not intended to be limited to the details shown, since various modifications and structural changes may be made therein without departing from the spirit  
20 of the invention and within the scope and range of equivalents of the claims.

The construction and method of operation of the invention, however, together with additional objects and advantages  
25 thereof will be best understood from the following description

of specific embodiments when read in connection with the accompanying drawings.

Brief Description of the Drawings:

5 Fig. 1 is a diagrammatic, cross-sectional view through a power semiconductor module according to the prior art; and

Fig. 2 is an enlarged, partial, sectional view of a frame of a plastic housing according to the invention.

10

Description of the Preferred Embodiments:

In all the figures of the drawing, sub-features and integral parts that correspond to one another bear the same reference symbol in each case. Referring now to the figures of the drawing in detail and first, particularly, to Fig. 1 thereof,  
15 there is shown a power semiconductor module 1 containing a plastic housing 2, into which a substrate 4 is inserted as a housing base 3.

20 The substrate 4 contains a ceramic plate 5 provided with a metallization layer on its top side 6 and on its bottom side 7. The metallization layer on the top side 6 faces the interior of the housing 2 and is patterned to form interconnects. Semiconductor components 10 are applied on the  
25 top side 6 of the ceramic plate 5. The semiconductor components 10 are, as a rule, power semiconductor components

such as IGBTs, MCTs, power transistors or power diodes.

Furthermore, connecting elements 8 configured as aluminum wires are situated there. The connecting elements 8 are applied on the semiconductor components 10 by bonding methods.

5

The plastic housing 2 includes a frame 9 and a cover. Here terminal elements 11 for external terminals are injection-molded into the frame 9 according to the prior art.

10 In this case, the terminal elements 11 are injection-molded into the frame 9, which is composed of plastic, using a separate injection mold. The relevant terminal element is placed into the injection mold before each injection-molding process and is subsequently encapsulated by injection molding.

15

Fig. 2 shows a plastic frame according to the present invention, in which the terminal elements 11 are press-fitted into openings 12 in the plastic frame 9. The terminal elements 11 in this case have lugs 13, which bear on an inner  
20 side of the plastic housing 2. The terminal elements 11 are thereby fixed in their position. The lugs 13 have the function of barbs that secure the terminal elements 11 against unintentional withdrawal. The bonds between the terminal elements 11 and the semiconductor components 10 and/or  
25 connecting elements 8 are thereby secured against destruction.



The terminal elements 11 run approximately parallel to the housing base 3 in the interior of the housing 2. The plastic housing 2 shown here includes the plastic frame 9 and the cover. The substrate 4 is covered with a potting compound.

- 5 The potting compound is formed of a hard potting compound layer disposed on a soft potting compound layer.

We claim:

1. A power semiconductor module, comprising:

semiconductor components;

a plastic housing having an interior and connecting element openings formed therein;

a substrate disposed in said plastic housing defining a housing base of said plastic housing, said substrate containing a ceramic plate having a top side and a bottom side with a top metallization layer disposed on said top side and a bottom metallization layer disposed on said bottom side, said top metallization layer facing said interior of said plastic housing being patterned in order to form interconnects and equipped for and receiving said semiconductor components;

connecting elements interconnecting said semiconductor components; and

terminal elements for providing external terminals press-fitted into said connecting element openings in said plastic housing.

2. The power semiconductor module according to claim 1,

wherein said plastic housing has an inner side and said terminal elements have lugs which bear on said inner side for fixing said terminal elements in position.

3. The power semiconductor module according to claim 1, wherein said terminal elements run approximately parallel to said housing base in said interior of said plastic housing.

4. The power semiconductor module according to claim 1, wherein said plastic housing includes a frame and a cover.

5. The power semiconductor module according to claim 4, wherein said terminal elements are disposed in said frame.

6. The power semiconductor module according to claim 1, wherein said substrate is covered with a potting compound.

7. The power semiconductor module according to claim 6, wherein said potting compound is formed of a soft potting compound layer and a hard potting compound disposed on said soft potting compound.

Abstract of the Disclosure:

A power semiconductor module is presented in which terminal elements are press-fitted into openings in a plastic housing.

This measure improves the reliability of the internal bonds

5 between the substrate and the terminal element since there is no longer a risk of the terminal elements loosening in the plastic housing.

10 REL/tg

1/1  
Prior Art

FIG 1

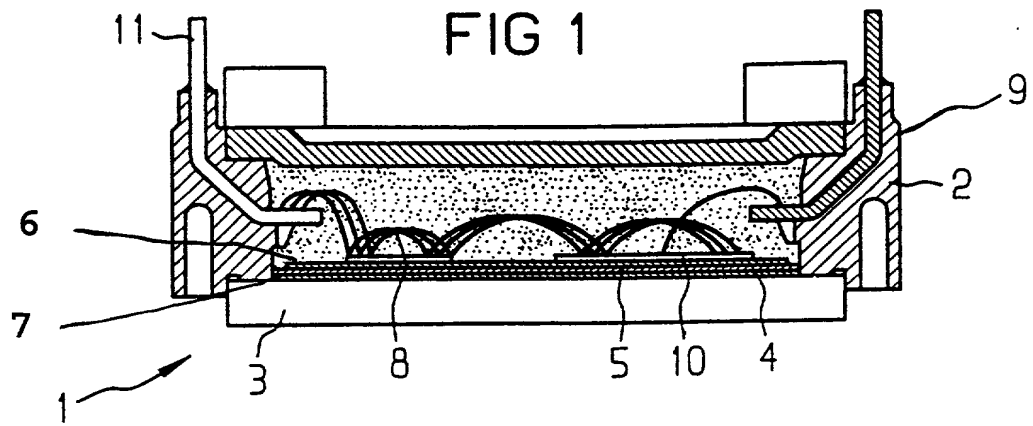
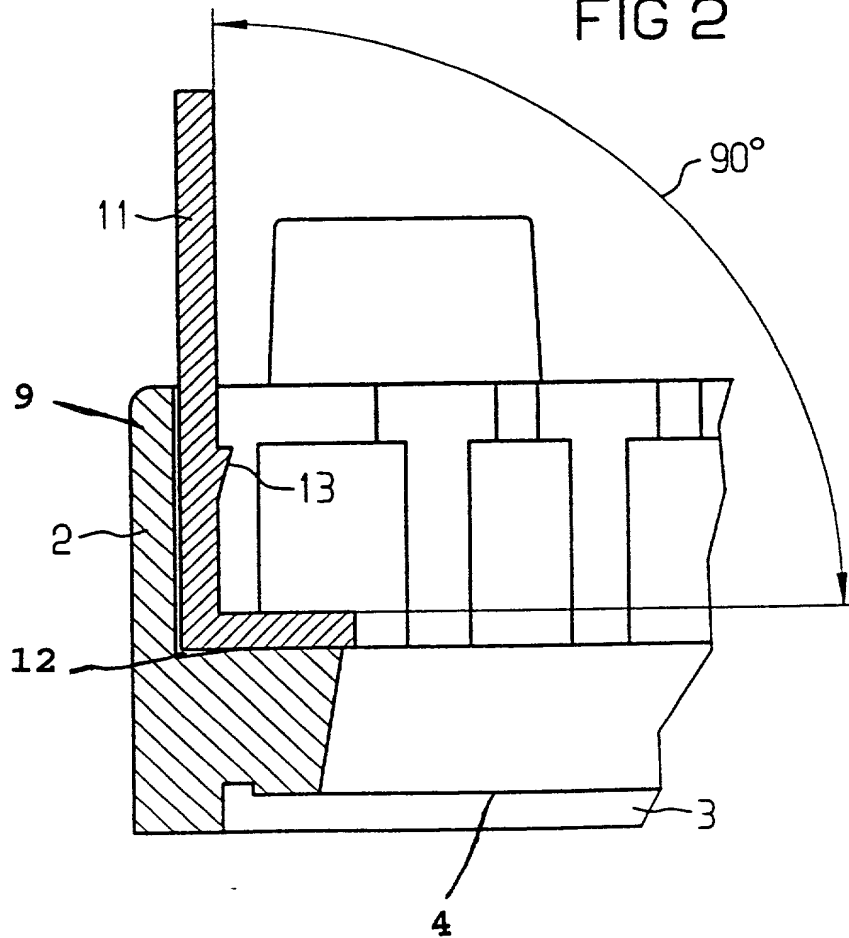


FIG 2



COMBINED DECLARATION AND POWER OF ATTORNEY  
IN ORIGINAL APPLICATION

As a below named inventor, I hereby declare that: my residence, post office address and citizenship are as stated below next to my name; that I verily believe that I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

POWER SEMICONDUCTOR MODULE WITH CERAMIC SUBSTRATE

described and claimed in the specification bearing that title, that I understand the content of the specification, that I do not know and do not believe the same was ever known or used in the United States of America before my or our invention thereof, or patented or described in any printed publication in any country before my or our invention thereof or more than one year prior to this application, that the same was not in public use or on sale in the United States of America more than one year prior to this application, that the invention has not been patented or made the subject of an inventor's certificate issued before the date of this application in any country foreign to the United States of America on an application filed by me or my legal representatives or assigns more than twelve month prior to this application, that I acknowledge my duty to disclose information of which I am aware which is material to the examination of this application under 37 C.F.R. 1.56a, and that no application for patent or inventor's certificate of this invention has been filed earlier than the following in any country foreign to the United States prior to this application by me or my legal representatives or assigns:

German Application No. 197 19 703.5, filed May 9, 1997, the International Priority of which is claimed under 35 U.S.C. §119; and International Application No. PCT/DE98/01266, filed May 7, 1998, the Priority of which is claimed under 35 U.S.C. §120.

I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith:

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I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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